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TECHNICAL MANUAL

PLUMBING

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DEPARTMENTS OF THE ARMY AND THE AIR FORCE

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DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
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PLUMBING

LIST OF FIGURES

***This manual supersedes TM 5-810-5/AFM 88-8, Chapter 3, dated 12 January 1990**

LIST OF TABLES

CHAPTER 1
GENERAL

1-1. Purpose

This manual provides guidance in the design of plumbing systems, together with the criteria for selecting plumbing materials, fixtures, and equipment and is applicable to all elements of the Army or Air Force charged with planning military construction.

1-2. Scope

The design of all plumbing will comply with the National Standard Plumbing Code, unless otherwise stated. In general, it is not the intent of this manual to duplicate information contained in this and other standards cited herein, but to reference them as appropriate. A plumbing system is considered to consist of the water supply distribution system; fixtures, and fixture traps; soil, waste, and vent piping; storm water drainage; and acid and industrial waste disposal systems and extends from connections within a structure to a point 5 feet outside the structure.

1-3. References

Appendix A contains a list of references used in this document.

1-4. Basic principles

In addition to the basic principles outlined in the National Standard Plumbing Code, the following principles will be incorporated into all designs.

a. Siting. Whenever possible, buildings, sewers, and water mains should be sited and designed to avoid the need for sewage lifts or water booster pumps.

b. Piping runs. Piping runs will be arranged to minimize interference with ordinary movement of personnel and equipment. Water and waste piping will not be located in exterior walls or attic spaces where there is danger of freezing.

c. Protection of electrical equipment. Neither water nor drainage piping will be located over electrical wiring or equipment unless adequate protection against water (including condensation) damage has been provided. Insulation alone is not adequate protection against condensation.

1-5. Drawings

The drawings will be accurate and to scale. Graphic symbols will be in accordance with ANSI Standard Y32.4. Fixtures, equipment, and piping will be shown in their proper locations. Large-scale details of congested areas will be provided on the drawings, with dimensions locating all work relative to structural features of the building. Each set of drawings will have a legend covering symbols and abbreviations as indicated in ASHRAE Handbook, Fundamentals. Where practical, all notes, legends, and schedules will be grouped at the right of the drawings above the title block. Riser diagrams of soil, waste, drain, and vent stacks and water risers will be shown for all buildings in excess of one story. The grade of all drain lines will be calculated and invert elevations will be established.

a. *Equipmentnotes.* The following noteswill be included on the drawings, when applicable:

(1) Hot water circulating pumps:
- *(a)* Capacity in gallons per minute.
- *(b)* Total head in feet.
- *(c)* Minimum horsepower.
- *(d)* Volts, phase, hertz.

(2) Ejector or sump pump:
- *(a)* Capacity in gallons per minute.
- *(b)* Total dynamic head in feet.
- *(c)* Minimum horsepower.
- *(d)* Volts, phase, hertz.

(3) Water heater:
- *(a)* Heating capacity in gallons per hour.
- *(b)* Temperature rise in degrees F.
- *(c)* Storage capacity in gallons.

(4) Hot water storage tank:
- *(a)* Dimensions.
- *(b)* Capacity in gallons.

(5) Hot water generator:
- *(a)* Dimensions.
- *(b)* Storage capacity in gallons.
- *(c)* Heating surface area.

(6) Drinking water dispenser:
- *(a)* Cafeteria : Type, size.
- *(b)* Electric drinking water cooler: Type, size,

(7) Grease interceptor:
- *(a)* Fat capacity in pounds.
- *(b)* Flow rating in gallons per minute.

(8) Reverse osmosis water treatment equipment:
- *(a)* Minimum flow rating in gallons per minute.
- *(b)* Design and operating temperature in degrees F.

(9) Water softening treatment equipment:
- *(a)* Minimum flow rating in gallons per minute.
- *(b)* Grains hardness to which water is to be softened.
- *(c)* Amount of water metered in gallons to start automatic regeneration of a softener unit.

b. Water service. The following note will be placed on the applicable drawing: “Water pipe sizes are based on a

minimum working pressure of ___psig at a flow rate of _ _ gpm at the location where the main service enters the building." When water pressure is not known, pressure will be assumed to be the pressure that will not exceed the required minimum residual pressure, plus allowances for pressure due to friction and pressure required for elevation of the highest water outlet.

1-6. Design analysis

The design analysis will include the following:

a. Design basis. Basis for design will consist of:

(1) Building population (number of males and number of females).

(2) Plumbing fixture determination, listing quantity and types of fixtures identified by federal or military specifications.

(3) Fixture units for drainage, venting, cold and hot water piping.

(4) Roof areas used in determining storm drainage pipe sizes.

(5) Capacities of all equipment and tanks.

b. Calculations. Calculationswill be shown clearly so that any changes that become necessary during construction or resiting may be made efficiently. When tables used in the design are taken from publications, the title, source, and date of the publication will be indicated. The model number and manufacturer of each major piece of equipment for which space was allocated will be provided along with the model number and manufacturer of a minimum of two other similar items (each produced by different manufacturers) that also meet the contract specification.

1-7. Central systems

Central systems for medical gas and vacuum will be in accordance with AFR 88-50.

CHAPTER 2

MATERIALS AND FIXTURES

2-1. Fixtures

a. Prohibited fixtures. Fixtures employing continuous-flow devices and fixtures that will backflow are prohibited. Continuous-flow devices cannot be used for water conservation reasons. Drainage fixtures not constructed with impervious materials will not be used.

b. Water conservation fixtures. Water conservation fixtures conforming to the National Standard Plumbing Code will be used except where the sewer system will not adequately dispose of the waste material on the reduced amount of water.

c. Fixture selection and mounting. Plumbing fixtures will be of the minimum quality required for the type of structure in which fixtures are to be installed, consideration being given to the expected life of the building and to energy conservation. Special care will be required in mounting lavatories and urinals in enlisted men's barracks or dormitories and in men's gang-toilet facilities (three or more water closets). Porcelain-enameled cast-iron lavatories will be provided in enlisted personnel barracks or dormitories or other gang-toilet facilities and will be installed to prevent uplifting.

2-2. Fixture allowances

a. Employee toilet facilities. Toilet facilities will be provided for employees as follows:

(1) Water closets. Water closets in separate toilet rooms for each sex will be provided in all places of employment according to table 2-l. The number of water closets to be provided for each sex will be based on the number of employees of that sex for whom the toilet facilities are furnished. Separate toilet rooms for each sex need not be provided when toilet rooms will be occupied by no more than one person at a time, can be locked from the inside, and contain at least one water closet. When such single occupancy rooms have more than one water closet, only one such fixture in each toilet room will be counted for the purpose of table 2-l.

Table 2-1. Water closet allowances.

Number of Employees	Minimum Number of Water Closets'
1 to 15	1
16 to 35	2
36 to 55	3
56 to 80	4
81 to 110	5
111 to 150	6
151 and over	6 for the first 150, plus 1 additional fixture for each additional 40 employees

'Where toilet rooms will not be used by women, urinals may be substituted for some water closets, except that the number of water closets in such cases will not be reduced to less than two-thirds of the minimum specified.

(2) Lavatories. Lavatories will be made available in all places of employment according to the requirements for lavatories as specified in table 2-2. In a multiple-use lavatory, 24 lineal inches of wash sink or 20 inches of a circular basin, when provided with water outlets for each space, will be considered equivalent to one lavatory. Lavatories in toilet rooms for food service employees will be provided with other than hand-operated valves.

Table 2-2. Lavatory allowances.

Type of Employment'	Number of Employees	Minimum Number of Lavatories
Nonindustrial office buildings, public buildings, and similar establishments	1 to 15	1
	16 to 35	2
	36 to 60	3
	61 to 90	4
	91 to 125	5
	126 and over	1 additional fixture for each additional 45 employees

'For other types of employment, at least one lavatory for three required water closets will be provided.

(3) Other users. When persons other than employees are permitted the use of toilet facilities on the premises, the number of fixtures will be appropriately increased according to paragraph 2-2c when determining the minimum number required.

(4) Drinking fountains. One drinking fountain for each 75 employees or fraction and at least one fountain per floor will be provided.

b. UOPH & UEPH. Plumbing fixture allowances for Unaccompanied Officers Personnel Housing (UOPH) will be according to table 2-3. Plumbing fixture allowances for Unaccompanied Enlisted Personnel Housing (UEPH) will be according to table 2-4.

Table 2-3. Fixture allowances for UOPH.

Occupant	Fixtures
WI to 06	Bathroom for each suite will provide one lavatory, one water closet, and one bathtub with shower. Each floor will include one drinking fountain

c. Other occupancies. Plumbing fixture allowances for religious, welfare and recreational facilities for persons other than employees, where separate toilet facilities are provided, will be according to table 2-5.

Table 2-4. Fixture allowances for UEPH (minimum number of persons per future).

Occupants	Water Closets	Showers[1]	Lavatories	Bathtubs	Urinals	Drinking Fountains
Recruits[2]						
Male	10	8	8	0	15	75[3]
Female	6	8	6	30[6]	None	75[3]
E1 to E4[5]	4	Note [6]	2	4[7]	None	Note [4]
E5 and E6[5]	2	Note [6]	1	2[7]	None	Note [4]
E7 and E9[5]	1	Note [6]	1	1	None	Note [4]

[1]Not less than 3 ft by 3 ft net area.

[2]The figures listed for recruits are also applicable to bathroom facilities for prisoners in confinement facilities.

[3]An additional drinking fountain will be provided in recruit housing for every 30 occupants per floor above the initial 75 occupants requirement.

[4]0ne drinking fountain per floor will be provided in UEPH projects.

[5]The fixtures listed in this table equal the criteria for the standard 2-person living/sleeping room suite required to be used when constructing new UEPH buildings and will be followed in UEPH modernization projects to the maximum extent possible. However, in UEPH modernization projects, if providing semiprivate bathroom facilities in living/sleeping room suites for all enlisted personnel is impractical, then private living/sleeping room suites with private bathrooms containing one water closet, one lavatory, and one combination bathtub with shower will be provided for E7 to E9 personnel; and semiprivate living/sleeping room suites served by central bathroom facilities conveniently located to those living/sleeping room suites will be provided for E1 to E6 personnel. E1 to E4 and E5 and E6 personnel will be provided with separate central bathroom facilities. Generally, central bathroom facilities will have a minimum of two water closets and two lavatories, and service not more than 30 persons.

[6]Showers maybe substituted for bathtubs at the discretion of the Major Command and installation commander.

[7]Combination bathtubs with shower fixtures will be provided at the rate indicated in the bathtub column. One shower will be substituted for each combination bathtub with shower fixture authorized at the discretion of the Major Command and installation commander.

Table 2-5. Plumbing fixture allowances for facilities where separate toilet facilities are provided for persons other than employees (minimum number of persons per fixture when more than one fixture is required).

Occupancy	Water closets	Lavatories	Urinals	Showers	Drinking Fountains
Bowling Alley			Joint facilities for employees and patrons will be provided according to tables 2-1 and 2-2.		
Chapel (Congregation only)					
Male	300	150	300	None	400
Female	150	150	None	None	400
Enlisted Personnel Service Club (Patrons only)					
Male	150	150	200	None	500
Female	100	100	None	None	500
General Education Development (GED) Building (Students only)					
Male	40	25	40	None	100
Female	25	25	None	None	100
Gymnasium, Field House (does not include fixtures for component swimming pools) (Athletic participants only - pectators according to theaters below)					
Male	30	30	40	15	100
Female	20	25	None	15	100

Table 2-5. (continued)

Occupancy	Water closets	Lavatories	Urinals	Showers	Drinking Fountains
Installation (Post) Restaurant or Cafeteria, NCO's Open Mess, Officers' Open Mess (Patrons only)					
Male	200	200	300	None	500
Female	150	150	None	None	500
Library			Joint facilities for employees and patrons will be provided according tables 2-1 and 2-2.		
Recreational Workshop Swimming Pool [1,2] (Swimmers only)					
Male	40	40	40	30	100
Female	20	40	None	30	100
Temporary Lodging			Provide the following fixtures for each two guest rooms: One water closet, two lavatories, and one shower compartment or bathtub. In addition, a common toilet room will be provided for the office and lounge.		
Theater, Bus and Taxicab Ticket Station, Enlisted Personnel Dining Facilities[3] (Patrons only)					
Male	250	200	250	None	400
Female	150	150	None	None	400

[1]Fixtures will be provided for swimmers only on this basis: The maximum capacity of the pool (swimmers) will equal the area of the pool (square feet) divided by 27. Where applicable, fixtures for waders will be computed on the basis of not less than 13-1/2 ft^2 per wader instead of 27 ft^2 in depth of less than 5 feet. Separate fixtures will be provided for spectators at indoor swimming pools as indicated opposite "theater" above.

[2]In addition to the above fixtures, "wet toilets" required by wet swimmers and located adjacent to shower rooms will be provided as follows: One "wet toilet" for women, consisting of one water closet for 100 swimmers or less, and two water closets for over 100 swimmers. The "wet toilets" will be so placed that persons using them must pass through the shower before entering the pool.

[3]Patron toilet facilities are not required in enlisted personnel dining facilities that are adjacent to other toilet facilities in existing UEPH buildings. Separate toilet facilities will be provided for kitchen employees according to tables 2-1 and 2-2.

2-3. Selection of piping and storage tank materials

The classification of potable water in c below provides the basis for the selection of piping materials for plumbing systems in permanent buildings. The selection of pipe and fitting materials for acid waste and vent applications will be based upon the type, concentration, and temperature of acid wastes to be handled.

a. Pipe and fittings materials. Installation procedure for plastic piping materials will be in accordance with the Plastic Pipe Institute (PPI), Plastic Piping Manual Design parameters such as thermal, movement, chemical resistance, flow characteristics, and pressure ratings are covered in this manual. The designer should be aware that some schedule 40 plastic pipes might have a strength of less than one-tenth that of the strength of a schedule 40 steel pipe; therefore, the desired working pressure ratings for any plastic piping specified must be indicated either in the specifications or on the drawings.

b. Storage tank materials. Storage tanks will be constructed of one of the following combinations of materials and methods:

(1) Ferrous metals lined with nonferrous metals and provided with cathodic protection.

(2) Ferrous metals lined with glass and provided with cathodic protection.

(3) Ferrous metals lined with cement and provided with cathodic protection.

(4) Fiberglass reinforced plastic for atmospheric pressure applications.

c. Piping selection. Selection of pipe, valves, and fittings will be in accordance with the quality of the water.

(1) Classification. Water quality is classified under the following categories:

(a) Category 1: Calcium plus magnesium content 0 to 35 parts per million (ppm) expressed as calcium (Ca). For this type of water, pipe, valves, and fittings will be nonferrous for both hot- and cold-water service.

(b) Category 2: Calcium plus magnesium content 35 to 75 ppm. For this type of water, pipe, valves, and fittings may be ferrous for cold-water service, when sulfates (SO_4) are less than one and one-half times the calcium content. If the sulfate content is more than one and one-half times the calcium content, pipe, valves, and fittings will be nonferrous for cold-water service. All pipe, valves, and fittings for hot-water service will be nonferrous.

(c) Category 3: Calcium plus magnesium content more than 75 ppm. For this type of water, pipe, valves, and fittings may be ferrous for cold-water service and nonferrous for hot-water service if the sulfates (SO_4) are less than twice the calcium content. If the sulfates are more than twice the calcium content, pipe, valves, and fittings will be nonferrous for hot and cold-water service.

(d) Category 4: Pipe and fittings for salt-water service will be of thermoplastic or thermosetting plastic. Valves will be plastic or nonferrous metal.

(2) Discussion. In the absence of actual experience at a specific location, the categories shown above, especially category 1, are satisfactory for the selection of potable water piping. Nonferrous piping is recommended for hot-water service regardless of water category and is also recommended for cold water installations when piping is concealed in walls, partitions, and floors, where replacement would be difficult and expensive, and when the piping is 3 inches in diameter or less. High-chloride content, especially in category 2 and 3 waters, will have a corrosion-causing effect similar to high-sulfate content. If local experience shows that ferrous piping in category 2 and 3 waters has a satisfactory life of 20 to 25 years, ferrous pipe may be used for cold-water service, provided piping is not concealed and replacement can be accomplished economically. Where dissimilar metals are joined underground or at water heaters, insulated jointswill be installed at those points to break the galvanic couple.

2-4. Backwater valves and floor drains

a. Backwater valves. In addition to the requirements outlined in the National Standard Plumbing Code, a gate valve will be installed on the sewer side of each backwater valve, and both will be installed in a manhole.

b. Floor drains. Floor drains will be provided in structures having gang toilets and gang shower drying rooms. Gang toilets will be interpreted as those having three or more water closets, and gang shower drying rooms as those serving two or more showers. Trap primers will be installed where traps are subject to drying out in order to insure a proper water seal.

(1) Floor drains will not be provided in walk-in and reach-in refrigerators, except in cold-storage warehouses, as follows:

(a) Fat-rendering rooms.
(b) Processing rooms.
(c) Salvage rooms.
(d) Receiving rooms.
(e) Meat coolers.
(f) Milk, butter, and egg rooms.
(g) Fruit and vegetable rooms.
(h) Receiving and issue vestibules.

(2) Floor drains will be provided normally in kitchens at the following locations:

(a) Dishwashing area.
(b) Scullery or pot-washing area.
(c) Steam-jacketed kettle area.
(d) Vegetable peeler area.
(e) Vegetable preparation area.
(f) Adjacent to walk-in and reach-in refrigerators (20 cubic feet or larger).
(g) Adjacent to icemaking machines.
(h) Adjacent to garbage disposals.
(i) Washing areas.

CHAPTER 3
EQUIPMENT

3-1. Pumps and ejectors

Detailed requirements for pumps and ejectors will be in accordance with the standards of the Hydraulic Institute.

a. Sewage pumps. Where sewers are not of sufficient depth to drain the lower floor fixtures by gravity, the main toilet rooms should be located on higher floors. The capacity will be determined by the fixture unit method described in the National Standard Plumbing Code. When the sewage must be pumped, duplex units will be provided below the lowest floor in a concrete pit protected by a safety railing. Duplex sewage pumps will be installed in a separate pump house when the sewage from a group of buildings must be pumped and where it is not possible to install sewage pumps in the buildings. Pump motors will be located so as not to become submerged by an electrical service interruption. Packaged pumping systems installed in vertical dry or wet basins with nonclog centrifugal pumps are acceptable, if the influent line leads directly to the discharge line of both pumps and all incoming sewage passes through self-cleaning screens. Auxiliary screens will be installed in influent lines within wet wells, since built-in self-cleaning screens of the pump discharge lines may not be able to handle extreme peak-flow conditions. Combination "T" and check-valve arrangements will be provided in the influent line to each pump to prevent raw sewage from backing into incoming sewer lines, when pumps are operating.

b. Sewage ejectors. Sewage ejectors will be of the duplex pneumatic type and will be located in a concrete pit below the lowest floor. Units will utilize a high-velocity steam, air, or water jet for ejecting the sewage.

c. Sump pumps. Sump pumps will be installed in pits below the lowest floor. Subsoil drains may discharge into this pit. The depth of the pit, below the finished floor, will be in even feet to conform to standard lengths of submerged pump shafts. Pumps with discharge capacities in excess of 25 gallons per minute and with a total head of at least 20 feet will be of the duplex type.

d. Circulatingpumps. Criteria determining the need for circulating pumps in ASHRAE HANDBOOK HVAC Systems and Applications will be followed. Pump sizing will also be in accordance with simplified method in ASHRAE unless specific conditions warrant the need for more detailed calculations.

e. Boosterpumps. Booster pumps will be installed when the water pressure to the building is inadequate. Automatic pressure-actuated controls on the suction side of each pump will operate the pump only when necessary to maintain an adequate pressure in the supply piping. A minimum of three pumps will be provided. Minimum capacity for each pump, in gallons per minute, will be based on 50 percent of the total calculated pump load. The third pump will be a standby unit. Two pumps will alternate operation, except that both pumps will operate when the water in storage drops to a predetermined low level. The third pump will be operated by a manual transfer switch.

3-2. Water pressure booster system

For systems having inadequate water distribution pressure, the following types of systems should be analyzed as to regularity of water flow, allowable water pressure variation, and installed cost.

a. Constant speed pumping system. A constant speed pumping system will not be used where periods of low flow are encountered, since this is a waste of electric energy.

b. Variable speed pumping system. This type of system provides more even pressure than a constant speed system, but is more costly.

3-3. Tanks

Hydro-pneumatic tanks will be provided in buildings to furnish the required volume of water where the pressure on the water supply system is either not adequate to provide the necessary volume or cannot be boosted to a pressure which would provide adequate volume.

3-4. Interceptors

Grease interceptors will be installed underground outside the building. Waste piping from prewash sinks, prewash compartment of dishwashers, pot and pan sinks, or grease disposing sinks will be connected to interceptors. The area surrounding interceptors will be paved and provided with suitable drainage facilities. Where design temperatures are less than 0 °F, interceptors should be located within the building, remote from the kitchen area.

3-5. Food waste grinders

Food waste grinders are authorized in Army and Air Force permanent quarters, hospitals, and dining facilities when the sewage treatment plant can handle the additional load. Design of new sewage treatment plants and additions to existing plants will be based on the increase in load that will result from food waste grinders installed in hospital, dining facilities, and the ultimate projected number of family quarters to be constructed. Food waste grinders installed in hospital kitchens and dining facilities will be sized as shown in table 3-1. Food waste grinders will not discharge into a grease interceptor.

Table 3-1. Size of food waste grinders.

Persons served	Pot washer horsepower	Dishwasher horsepower
up to 200	2	3
200 to 500	3	5
501 to 1,000	5	7-1/2
Over 1,000	7-1/2	10

3-6. Reverse osmosis water treatment equipment

Reverse osmosis water treatment systems will be installed when water of a higher purity than that produced by the domestic water is required, such as for deionized or distilled water systems used in hospitals. A water quality analysis will be performed and water treatment design will proceed based on that analysis. Reverse osmosis is a general term covering equipment which can have various types of filter elements and membranes and polishing components. The reverse osmosis membrane selection is critical and the operating pressure depends upon the membrane selected. Pump pressures can range from 80 to 800 psi. The reverse osmosis unit is only part of the required treatment systems, which may include pretreatment facilities and organic filters. In some cases, booster pumps may be required for final water distribution. Materials for piping, pumps, valves, and other components must be carefully selected due to the corrosive nature of the high-purity water produced.

3-7. Water softening treatment equipment

Normally, water softening treatment equipment will be installed, when the water analysis performed indicates a total water hardness exceeding 1.0 grams per gallon, (17 ppm) expressed as calcium carbonate. Also, water softening usually is required at laundries, mess halls, and hospitals. Each category has its own recommended limits for maximum hardness. Water hardness for laundries should not exceed 2.5 grains per gallon (43 ppm) and water hardness is usually reduced to zero. Large mess halls should have a water hardness not exceeding that provided for laundries; whereas, hospitals can utilize water of up to 3 grains per gallon (51 ppm) water hardness. Water softening equipment consists of a softener unit and a regeneration brine tank utilizing common salt (NaCl) for regeneration of the softener exchange material. Softening units can be multiple units where two or more units utilize the same regenerating brine tank to provide for continuity of treatment during regeneration of a softening unit.

3-8. Central drinking water systems

Central drinking water systems should be evaluated as an alternative to unitary water coolers in facilities where 15 or more drinking stations are required. Evaluation should include potential heat recovery from central condenser, addition of heat to building envelope by unitary condensers, differences in anticipated energy usage, and differences in first cost.

CHAPTER 4

WATER SUPPLY DISTRIBUTION

4-1. Quality of water

A nonpotable water supply, when used in an entirely separate system and when approved by the local health department, may be used for flushing water closets and urinals, and for other approved purposes where potable water is not required. Piping containing nonpotable water, that is water not meeting accepted potable water standards, will be labeled "NONPOTABLE WATER, DO NOT DRINK."

4-2. Protection of water supplies

Water pumps, hydrants, appliances, and devices will be protected from surface water and outside contamination by approved covers, walls, copings, or casings. Gravity water supply tanks will be covered tightly to keep out foreign materials. Soil or waste lines will not be permitted to pass directly over such tanks. Water pipes, storage tanks, cisterns, and appliances subject to freezing temperatures will be protected. Underground water pipes will be installed below the recognized frost line or will be insulated to prevent freezing. The supply outlet connection to each fixture or appliance that is subject to back-siphonage of nonpotable liquids, solids, or gases will be protected in accordance with the National Standard Plumbing Code. Depending on the severity of the backflow situation, an airgap atmosphericvacuum breaker, double check valve assembly, or reduced-pressure principle device may be required. Air gaps will conform to the National Standard Plumbing Code. Double check valve assemblies, reduced pressure principle assemblies, atmospheric (non-pressure) type vacuum breakers, and pressure type vacuum breakers will be tested, approved, and listed by the Foundation for Cross-Connection Control & Hydraulic Research. Pipe-applied atmospheric type vacuum breakers, hose connection vacuum breakers, and backflow preventers with intermediate atmospheric vent will be in accordance with American Society of Sanitary Engineering (ASSE) Standards 1001, 1011, and 1012.

4-3. Water service

Water service pipes will be sized in accordance with the National Standard Plumbing Code or American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Handbook, Fundamentals. When the pressure of water supply to building exceeds the required water pressure by 10 psig, a pressure reducing valve will be provided. Consideration will be given to increasing pipe sizes based on the anticipated future installation of fixtures when performing design calculations.

4-4. Service water heating

Service water heating temperatures will be in accordance with ASHRAE Handbook, HVAC Applications except the temperatures for services listed in table 4-1.

Table 4-1. Water service temperatures.

Service	Degrees F
General use such as showers, sinks, family housing, administration facilities, etc.	120
Commercial type dish washers with internal boosters.	140
Commercial type dish washer without internal boosters.	180
Commercial type laundries.	180

In addition to criteria provided in ASHRAE Handbook, HVAC Applications for the selection of heating equipment and storage facilities, consideration should be given to differences in costs of building area required to support systems when calculating life cycle costs.

a. Automatic control. In buildings operated on a nominal 40-hour week or on a nominal two-shift basis (either a 5- or a 7-day week), a clock or other automatic control will be installed on domestic hot-water circulating pumps to permit operation only during periods of occupancy plus 30 minutes before and after.

b. Energy conservation investment program. In older buildings or in unusual cases it maybe necessary to do more than reset existing temperature controls in order to save energy. Added storage tanks, temperature blending equipment, or separate lines may be required. Where the aggregate of this work on any one installation meets the minimum requirements for the Energy Conservation Investment Program, (ECIP), consideration should be given to including the work under this program, if the ECIP amortization guidelines can be met.

c. Other considerations.

(1) Gas used for fuel will be considered as having the heating values (expressed in Btu per cubic foot) given in table 4-2.

(2) Because of the high operating cost of electrical equipment, electricity is not used for large-volume water heating when natural gas is available. The fuel equivalent of electricity is 3,415 Btu/kWh.

Table 4-2. Gas heating values.

Type of gas	Btu per cubic foot
Natural gas	1,025
Propane	2,500
Butane	3,393

(3) Solar energy will be evaluated as a means of meeting all or part of the hot-water requirements if required by design instructions. Conventional back-up heating equipment will be provided for periods when high demand or an extended period of cloudy days exceeds the capacity of the solar energy system.

d. Water treatment. Control of scale formation will be provided with central water treatment on the hot-water system. This system till be in accordance with TM 5-813-3 /AFR 88-10, Vol. 3.

e. Relief valves. In general, each hot water heater, generator, or boiler will be equipped with either separate temperature and pressure relief valves or a combination temperature and pressure relief valve. Hot water storage tanks will be equipped with a pressure relief valve.

CHAPTER 5
WATER PIPING SYSTEMS

5-1. General layout

In designing water piping layouts, consideration will be given to delivery of water, accessibility of service valves, drains, water piping systems, lawn faucets, and hydrants. Large buildings will be provided with two or more water services to ensure constant delivery to all fixtures and equipment. Service lines will enter the building in an accessible location. Drains will be installed on the fixture side of all service valves located inside a building. The water supply piping will be distributed throughout the building, with mains generally running near the ceiling of the lowest floor. Water piping will not be located in exterior walls or other spaces where there is danger of freezing. Cross connections between water supply piping and waste, drain, vent, or sewer piping are prohibited. Piping will be designed so that a negative pressure in the water supply pipe and a stopped-up waste, drain, vent, or sewer pipe will not cause backflow of waste water into the water supply piping. Single check valves are not considered adequate protection against back flow.

5-2. Water for plantings

a. A means of watering lawn areas, flower beds, and gardens will be provided as follows:

(1) Wall faucets with vacuum breaker backflow preventer on outside walls in nonfreezing climates.

(2) Wall hydrants with vacuum breaker backflow preventer on outside walls in freezing climates.

(3) Lawn faucets with vacuum breaker backflow preventer for garden and lawn areas in nonfreezing climates.

(4) Yard hydrants with vacuum breaker backflow preventer for garden and lawn areas in freezing climates.

b. Wall faucets, wall hydrants, lawn faucets, and yard hydrants will be located so that, with 100 feet of garden hose, the area can be watered without crossing the main entrance of public buildings or barracks. The branch to the lawn faucets and yard hydrants will be equipped with stop and waste valves.

5-3. Standpipes and hose systems for fire protection systems

Standpipes and hose systems will be designed in accordance with MIL HNDBK 1008A.

5-4. Expansion of piping

Expansion of piping will be computed by the method outlined in the ASHRAE Handbook, Equipment. Expansion of plastic piping will be determined from the Plastic Pipe Institute (PPI) Technical Report PPI-TR21, Thermal Expansion and Contraction of Plastic Pipe.

5-5. Water hammer arresters

Commercially available water hammer arresters will be installed where necessary according to manufacturers recommendations. Vertical capped pipe columns are not permitted.

5-6. Kitchen and scullery area piping

Piping will be concealed wherever possible. Exposed piping attached to or near fixtures or equipment, or subject to high heat or frequent washing, will be copper, brass, or chromium plate. Other exposed piping will be primed with a paint suitable for metal surfaces and finish- painted with color to match background.

CHAPTER 6

DRAINAGE SYSTEMS

6-1. Types of systems

The data covered in this chapter include sanitary drainage, vents and venting, and storm drains. The design work will be in accordance with the National Standard Plumbing Code.

a. Indirect waste. Wastes from stills, tank overflows, relief valve discharges, and equipment used for the sterilization of materials or for storage, preparation, or processing of food or drink must discharge indirectly into the drainage system through an air gap, to an acceptable receptacle. The developed length of an indirect waste will be kept at a minimum with an air gap. Drains from water tanks and discharge from hydraulic elevator sumps will not be connected directly to the drainage system.

b. Arms vault and storage areas. Through-the-wall drains with discharge to grade will be provided in arms vaults and storage areas requiring dehumidification, to dispose of condensate water from dehumidifiers. When such drains are not practicable, floor drains will be installed inside the vaults or storage areas to provide for water removal.

6-2. Vents and venting

Design of vent systems will conform to figure 6-1. The seal of every fixture trap in a plumbing system will be protected by an individual vent in accordance with the National Standard Plumbing Code. A branch vent, circuit vent, individual vent, common dual vent, loop vent, relief vent, or stack vent, or a combination of two or more of these vents, is considered adequate protection for trap seals.

6-3. Storm drainage

Storm drainage will include roof drains, leaders, and conductors within the building and to a point 5 feet outside the building. Roof drainage systems will be designed in accordance with rainfall intensity-frequency data in TM 5-820-1/AFR 88-5, Vol. 1. Storm drainage outside buildings and building perimeter foundation drainage systems are not covered by this manual.

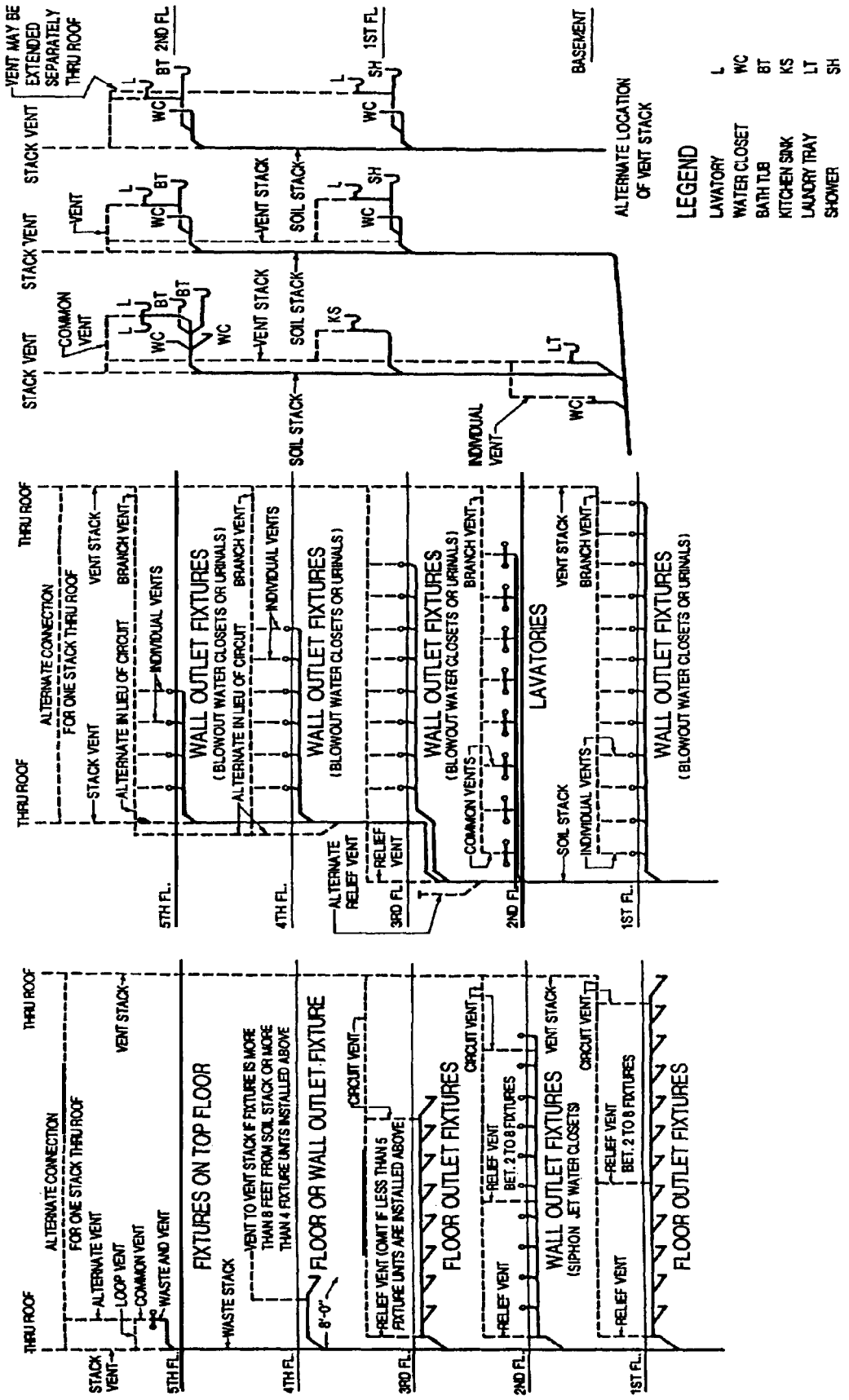

Figure 6-1. Soil, waste, and vent diagrams.

APPENDIX A
REFERENCES

Government Publications

Department of Defense

Military Handbook 1008A	Fire Protection for Facilities Engineering, Design, and Construction

Departments of the Army

TM 5-813-1/AFR 88-10, Vol. 1	Water Supply General Considerations
TM 5-8l3-3/AFR 88-10, Vol. 3	Water Supply Water Treatment
TM 5-820-1/AFR 88-5, Vol. 1	Surface Drainage Facilities for Airfields and Heliports
TM 5-842-2	Laundries and Dry Cleaning Plants
AFR 88-50	Medical Facilities Design, Air Force

Federal Specifications

WW-P-541	Plumbing Fixtures

National Bureau of Standards (NBS), National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161

Publication COM 75-1045 (52 pages) Monograph 31

National Oceanic & Atmospheric Administration (NOAA), Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402

Atlas II Precipitation Frequency Atlas of Western States

Nongovernment Publications

American National Standards Institite (ANSI), 1430 Broadway, New York, NY 10018

ANSI Z21.22	Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems

American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE), 345 East 47th Street, New York, NY 10017

	Handbook, Fundamentals
	Handbook, HVAC Applications
Standard 90	Energy Conservation in New Building Design

American Society of Mechanical Engineers (ASME), United Engineering Center, 345 East 47th Street, New York, NY 10017

ASME Y32.4	Graphic Symbols for Plumbing Fixtures for Diagrams Used in Architecture and Building Construction
ASME Boiler and Pressure Vessel Codes	
Section IV	Heating-Boilers
Section VIII	Pressure Vessels, Division 1
Safety Code CSD-1	Controls and Safety Devices for Automatically Fired Boilers Part CW, Article 5

American Society of *Sanitary Engineering (ASSE),* 960 Illuminating Building, Cleveland, Ohio 44113

Standard 1001	Pipe Applied Atmospheric Type Vacuum Breakers
Standard 1011	Hose Connection Vacuum Breakers
Standard 1012	Backflow Preventers with Intermediate Atmospheric Vent

National Association of Plumbing-Heating Cooling Contractors (NAPHCC), P.O. Box 6808, Falls Church, VA 22046

NAPHCC-01	National Standard Plumbing Code

Foundation for Cross-Connection Control and Hydraulic Research (FCCHR), USC ATTN: BHE315, Los Angeles, CA 90098-0231

FCCHR-01	Manual of Cross-Connection Control

Hydraulic Institute (HI), 712 Lakewood Center North 14600, Detroit Avenue, Cleveland, OH 44107

HI-01	Hydraulic Institute Standards for Central, Rotary and Reciprocating Pumps

Plastic Pipe Institute (PPI), 355 Lexington Avenue, New York, NY 10017

PPI-01	Plastics Piping Manual

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